102954
1

Final Report on

Shock Recovery Experiments for Dynamic Property Measurements on Tantalum and Tantalum Alloys

Submitted to
Luke Hsiung, Staff Scientist, Materials Science and Technology Division, Chemistry & Materials Science Directorate, Lawrence Livermore National Laboratory (LLNL) P.O. Box 808, L-352; Livermore, CA 94551; Tel: (925) 424-3125; E-mail: hsiung1@llnl.gov

Prepared by
Chris Wehrenberg and Naresh Thadhani

A total of four shock recovery experiments have been performed on disc-shaped samples of tantalum and its alloys. Shock compression of the samples was achieved through parallel plate impacts with the 80mm single stage gas-gun, using a 4-sample recovery fixture. The recovery fixtures contained four different samples such that each sample was subjected to identical impact conditions. The four samples tested were pure pure polycrystalline Ta, cold-worked pure polycrystalline Ta, Ta-2.5wt% W, and Ta-10wt% W. The cold-worked sample was prepared via uniaxial compression of ~33%. Each sample was backed by a Tantalum momentum trap and the entire fixture employed a radial steel momentum trap to prevent unloading. Figure 1 illustrates a schematic showing an example of the four-sample target assembly employed for the present work. In order to minimize thermal excursions during the shock loading, flowing liquid nitrogen gas was used to cool the target fixture to between -25^{0}C to 0^{0}C prior to impact.

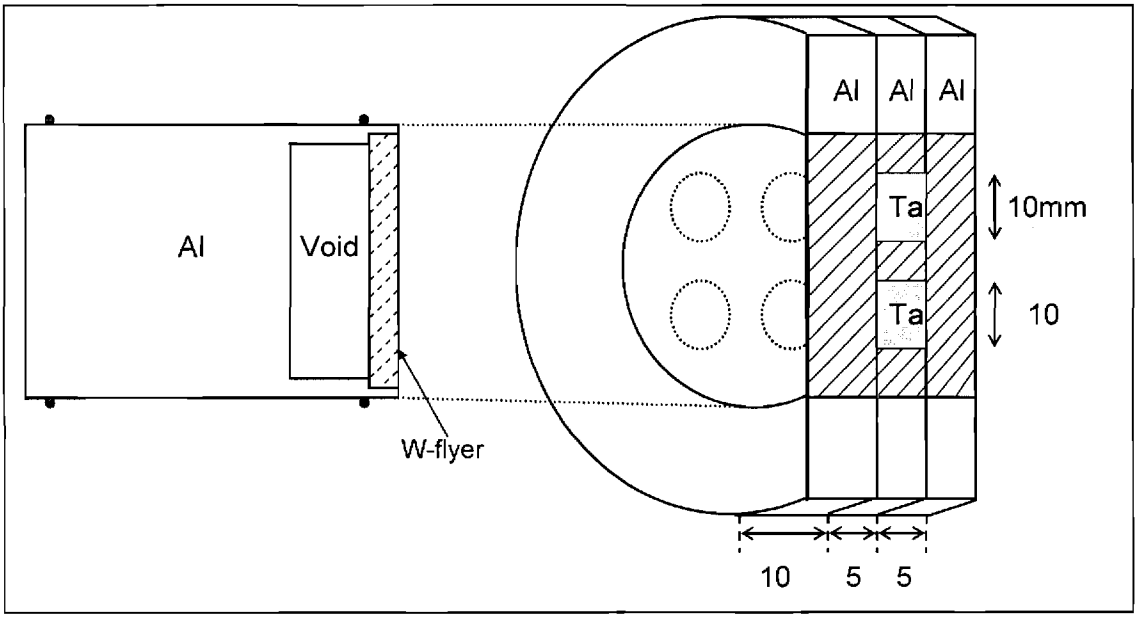

Fig.1. Schematic of the four-sample plate-impact shock recovery gas gun set-up.

A variety of flyer plate and impact velocity combinations were used to achieve nominal shock pressures of 10, 20, 30, and 40 GPa. The following table summarizes the experiment conditions.

Nominal Pressure (GPa)	10	20	30	40
Initial Diameter (Inch +/- .001)	0.750	0.750	0.750	0.750
Initial Thickness (Inch +/- .002)	0.239	0.238	0.265	0.274
Pre-Impact Temperature (C)	-9	< 0	-7	< 0
Flyer Plate Material	Brass 485	Brass 485	Tungsten	Tungsten Alloy
Impact Velocity (m/s)	465 +/- 15	885 +/- 95	804 +/- 7	1043 +/- 14
Simulated Pressure (GPa)	9.6 +/- 0.4	20.8 +/- 2.5	30.4 +/- 0.3	37.7 +/- 0.6

For those experiments where the pre-impact temperature is specified as $< 0^0$C, failure of the thermocouple required that established cooling rates be used to estimate temperature and ensure that the samples were well below 0^0C before impact. The Tungsten Alloy flyer plate were composed of 90%W-6%Ni-4%Cu. AUTODYN-2D simulations were used to predict the pressures achieved during each shock pulse. Upon recovery, the samples from 40 GPa experiment showed significant radial strain due to the smaller W flyer plate size needed to achieve the proper impact velocity.

All of the impacted samples have been sent to LLNL for further analysis.

We are currently redesigning the experiment geometry to perform an additional experiment at 40 GPa, with a recovery fixture that will allow shock loading of two samples (pure Ta and Ta-10wt%W) of ~0.5" diameter. The design will enable shock loading of the samples under uniaxial strain condition.